MSMR

MEDICAL SURVEILLANCE MONTHLY REPORT

CDC/Charles D. Humphrey

Norovirus Outbreak Associated with Person-to-Person Transmission, U.S. Air Force Academy, July 2011

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In July 2011, the U.S. Air Force School of Aerospace Medicine (USAFSAM) Epidemiology Consult Service investigated an ongoing outbreak of acute gastrointestinal (GI) illness – characterized by vomiting, nausea, diarrhea, and stomach cramps – that affected cadets and support personnel at a field training location at the U.S. Air Force Academy. Six outbreak-related stool specimens were confirmed by RT-PCR to be infected with norovirus, genogroup I. Overall, 290 cases (suspected and confirmed) of norovirus-related GI illness were recorded; the estimated attack rate among 1,359 cadets was 18%. The investigation suggested that norovirus was introduced into the field dining facility by one or more food service workers, possibly transmitted via common use serving utensils, and then further spread among cadets by person-to-person contact. Numbers of new cases sharply declined after ill cadets were segregated in separate tents for convalescence, and after all cadets moved from field billets (i.e., tents) to dormitories after completing the field training.

Acute gastrointestinal (GI) illnesses cause significant morbidity among and degrade the operational effectiveness of U.S. military members and their units. For example, in the past decade, acute GI illnesses have caused approximately 1,300 hospitalizations annually among active component members.[1]

In the general U.S. population, at least 50 percent of GI illness outbreaks are associated with noroviruses (genus *Norovirus*, family *Caliciviridae*). Noroviruses can be differentiated into five genogroups (I-V) that are further divided into genotypes. Genogroups I, II, and IV infect humans; genogroup II is the most common.

Norovirus-related illnesses are typically acute in onset. Clinical manifestations include non-bloody diarrhea, vomiting, nausea, abdominal pain and, less commonly, low-grade fever and body aches; of note, up to 30 percent of norovirus infections are asymptomatic. Noroviruses are extremely contagious. Transmission may occur from person-to-person or through ingestion of contaminated food or water. Person-to-person spread may be direct through the fecal-oral route or by ingestion of aerosolized vomitus, or indirect via contact with fomites or contaminated surfaces. Attack rates during outbreaks rarely exceed 50 percent due to the combination of asymptomatic infections and the potential for natural or acquired immunity.

Nearly half of all norovirus outbreaks in the United States are associated with ill food service workers.[2] Interventions to stop virus spread often involve exclusion of ill food service staff from work and isolation of infected persons until approximately 48 hours after their symptoms resolve.[3]

On 25 July 2011, the medical leadership at the U.S. Air Force Academy (USAFA) requested assistance from the U.S. Air Force School of Aerospace Medicine (USAFSAM) Epidemiology Consult Service to investigate an ongoing outbreak of GI illness at the USAFA installation. This report summarizes findings of a field investigation conducted from 26 July to 4 August 2011.

Setting

During 10-23 July 2011, 1,085 basic cadets (incoming freshmen), divided into 10 squadrons, and 274 upper class cadets (cadre) assembled at the Jacks Valley training site on the USAFA installation for 14 days as part of the annual Basic Cadet Training (BCT) program. The living conditions were typical for a field training site with shared sleeping tents and meals served in a common dining facility. Potable water was provided from a 400 gallon water trailer routinely treated with chlorine and tested three times daily to ensure adequate chlorine residual. The bathroom facilities had running water from municipal sources and it was considered potable. However, USAFA Bioenvironmental Engineering posted signs ("Do not drink this water") on bathroom faucets to encourage use of the water trailer rather than the faucets (which were reasonably expected to become soiled) to fill their canteens.

On the evening of 21 July 2011, the USAFA Public Health Flight was initially notified of seven basic cadets reporting to the Jacks Valley medical facility with symptoms of nausea, vomiting, and diarrhea. Patients were interviewed and three-day food histories were obtained.

By the next morning (22 July), approximately 50 basic cadets had presented with similar symptoms. A viral etiology was suspected, and three stool samples were collected from suspected cases. Over the next few days, increasing numbers of cases exceeded the capacity of the USAFA Public Health and Preventive Medicine staff to effectively investigate the source of the outbreak; assistance was requested from USAFSAM on 25 July.

Norovirus outbreaks are not unprecedented at the USAFA. For example, in 1988, the USAFA experienced a large point source norovirus outbreak that affected 48 percent of 3,000 cadets.[4] The source of the outbreak-related virus was raw celery (served in chicken salad) that had been washed with a hose that had been used to clean floor drains that were contaminated

during a sewage back-up. Also, GI illnesses are not uncommon during BCT. A review of surveillance data from 2008-2010 revealed a fairly consistent baseline GI illness rate (typically fewer than 10 clinic visits per day) during BCT.[5] The pattern was similar in 2011 until three days prior to the outbreak **(Figure 1)**. During 18-20 July, a small increase above baseline was noted; an abrupt influx of cadets with GI illness occurred on 21 July.

METHODS

Cases were identified from two sources: records of outpatient medical encounters at the USAFA Cadet Clinic and its satellite operations at Jacks Valley; and questionnaires administered via interview to basic and upper class cadets and food service personnel working at the Jacks Valley dining facility.

For the epidemiologic investigation, a "confirmed case" of norovirus was defined as nausea, vomiting, diarrhea, or stomach cramps with laboratory confirmation of the virus by reverse transcriptase polymerase chain reaction (RT-PCR) in a person associated with the Jacks Valley BCT program between 11 July and 31 July. "Suspected cases" were defined by the same criteria as confirmed cases but without laboratory confirmation of the virus. Chi-square analysis was used to determine the association between illness and potential exposures listed on questionnaires administered to cadets.

RESULTS

From 11 to 31 July 2011, 290 cases (suspected and confirmed) of norovirus-related GI illness were recorded. Among the cases, six were confirmed by RT-PCR to be infected with norovirus of genogroup I. Of those affected, approximately 70 percent (n=199) were males, and the median age was 19.6 years (range: 17-58) **(data not shown)**.

Most cases were basic cadets (n=234, 81%); however, food service (n=8, 3%) and health care (n=32, 11%) workers at

FIGURE 1. Daily clinic visits for gastrointestinal illness, U.S. Air Force Academy, 1-31 July 2008-2011
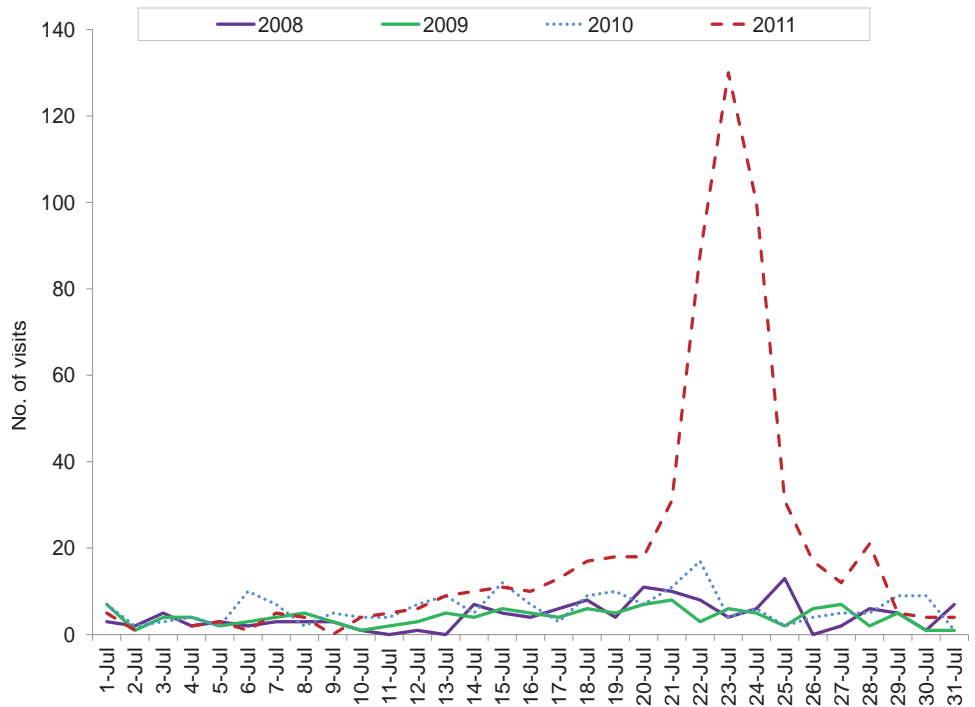
Jacks Valley were also affected. The average attack rate among basic cadet squadrons was 21.6 percent (range: 10%-46%) **(data not shown)**. The most frequent clinical symptoms among cases were vomiting (58%), nausea (57%), diarrhea (53%), and stomach cramps (37%) **(data not shown)**.

The earliest suspected norovirus case occurred on 11 July – one day after Jacks Valley training began – in a food service worker **(Figure 2)**; additional suspected cases occurred in food service workers on 14 and 15 July. Among basic cadets, the first case was noted on 18 July. Several more cases (suspected) presented during the next 2 days; however, clinic visits for GI illnesses remained near baseline levels until 21 July.
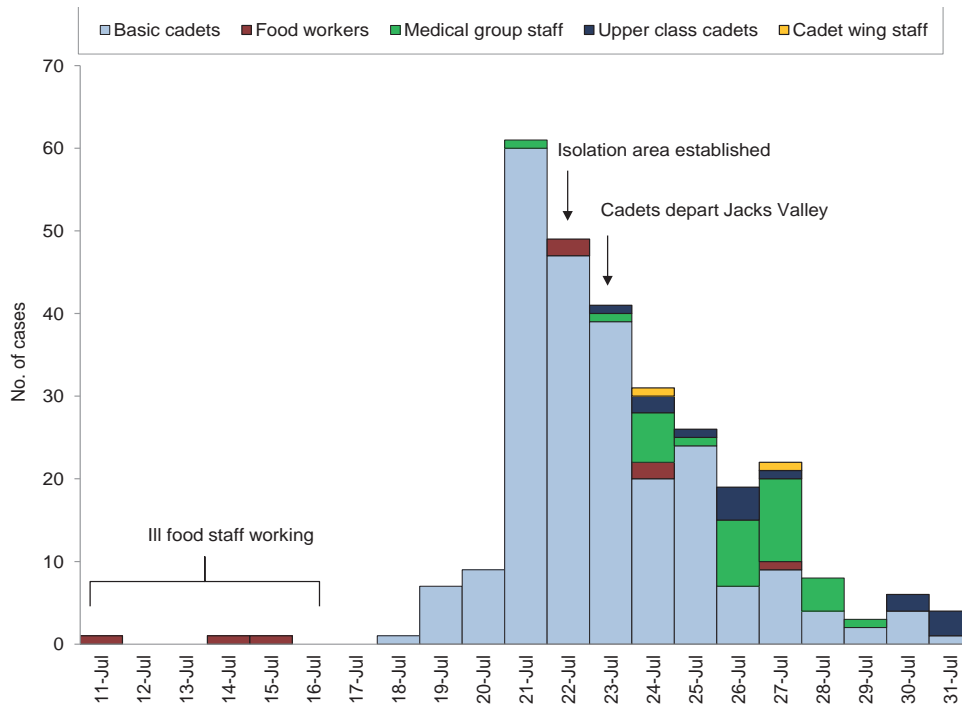
On 21 July, approximately 60 cadets became ill with complaints of vomiting, diarrhea and stomach cramps; nine of 10 squadrons reported cases on 21 July. The remaining squadron, whose members had been training at a nearby airfield on 20 July, did not report GI illness cases until 22 July. Cases quickly peaked and then steadily decreased; daily clinic visits

returned to background levels on or about 29 July 2011 **(Figure 2)**.

Of the 326 (244 male, 82 female) basic and upper class cadets interviewed regarding their exposures at Jacks Valley, 162 (50%) were ill with symptoms consistent with norovirus illness during the training period. Potential exposures included being in close proximity to someone who vomited, cleaning bathrooms at Jacks Valley, consuming water from a source other than the water trailer, and falling into water at an obstacle course used for training. Univariate analyses demonstrated strong associations between illness and two exposures: cleaning bathrooms at Jacks Valley and drinking or brushing teeth using water from a source other than the water trailer **(Table 1)**. No statistically significant associations were detected between illness and other exposures.

Of the 47 Jacks Valley food service workers interviewed, eight (17%) reported having GI illnesses consistent with norovirus at some point during BCT. Of the affected workers, only one called in sick; the others worked when they were ill (unless scheduled to be off).

FIGURE 2. Epidemic curve by date of onset of symptoms of gastrointestinal illness associated with Norovirus infection (suspected or confirmed), by patient category, U.S. Air Force Academy, 11-31 July 2011

nausea, vomiting, or diarrhea just prior to the recognized outbreak (18-20 July) were sent back to their tents for bed rest. It is not known whether any of these individuals were infected with norovirus because they were not tested; however, if they were infected, public vomiting in tents and excessive soiling of bathrooms may have exposed many other cadets to the highly contagious virus. Second, basic cadets were required to clean bathrooms and often did so with no protective gloves and little information on cleaning procedures (based on interviews with cadets). Exposure to cleaning bathrooms was associated with subsequent illness. It is reasonable to assume that infectious doses of norovirus were present in all facilities used by ill basic cadets; if so, healthy cadets would have been exposed to the virus while cleaning the contaminated bathrooms. Finally, during interviews, basic cadets reported lack of time for personal hygiene; as such, some cadets may have sacrificed proper hand washing after using the toilet.

Beginning on the evening of 21 July, no sick basic cadets were returned to the common tents; at approximately noon on 22 July, an isolation flight that segregated ill from well cadets was established; and on 23 July, cadets departed Jacks Valley and returned to dormitories where personal hygiene was easier to maintain; these measures were temporally associated with sharp declines in numbers of new norovirus cases **(Figure 2)**.

It is not certain why such a wide range of attack rates was observed among the 10 basic cadet squadrons (range 10%-46%). Serving line procedures and seating arrangement at meal time in the dining facility may have been factors. Cadets served themselves sequentially with common use utensils and sat at squadron-specific tables set by a food service worker. An ill cadet whose hands contaminated utensils in the serving line could have exposed those cadets who handled the utensils soon after. Likewise, if members of a particular squadron sat together at a table for a meal prepared and set by a food service worker with contaminated hands, this group may have been exposed to a greater infectious dose compared to other squadrons. Once several members of a squadron became

EDITORIAL COMMENT

This report documents a moderate-sized outbreak of norovirus-related illnesses that affected approximately 18 percent of 1,359 cadets. The investigation suggested that norovirus was likely introduced to the relatively isolated BCT population by one or more food service workers. An investigation conducted by the USAFA Public Health Flight during 21-24 July revealed no food-specific associations with illness among cadets. It is likely that exposure to norovirus occurred at the dining facility and involved contact with common use utensils used by cadets in the serving line rather than a food-borne vehicle. Based on interviews with food service workers, sinks designated for hand washing were not operable in the dining facility at Jacks Valley. Workers had to walk to nearby bathrooms to wash their hands; this situation challenged the maintenance of levels of cleanliness necessary for safe food preparation and serving.

Epidemiologic investigation suggested that a food service worker was the likely source of the norovirus that widely spread among the BCT cadets and cadre. It is possible, however, that an ill or asymptomatic cadet was the source of the outbreak-related norovirus. Sporadic episodes of vomiting and diarrhea were reported among cadets during early July but were at levels consistent with historical baseline levels. In the absence of laboratory testing, a case of norovirus during this period would almost certainly have gone unrecognized.

The sudden increase in GI illness cases involving multiple squadrons on 21 July suggests that widespread exposure to risk occurred on 20 July. Because each squadron had its own daily training activities, the dining facility was the only common exposure of all cadets at Jacks Valley on 20 July. Notably, the squadron that conducted training at a nearby airfield on 20 July did not eat mid-day or evening meals in the dining facility that day and had no cases of GI illness the following day.

Exposures to norovirus at the dining facility on 20 July likely led to the spike in GI illnesses on 21 July; however, person-to-person spread was likely responsible for the majority of subsequent cases and was facilitated by several factors. First, basic cadets presenting with symptoms of

TABLE 1. Attack rates of illness according to exposures of interest at Jacks Valley training site among 326 basic cadets interviewed, U.S. Air Force Academy, 11-31 July 2011

Exposure	No. (responders)	Attack rate in exposed	Attack rate in non-exposed	Odds ratio	p-value	95% CI
Close proximity (any location) to someone vomiting	326	51.7% (124/240)	44.2% (38/86)	1.4	0.23	0.82 – 2.22
Cleaning bathrooms at Jacks Valley[a]	326	52.3% (157/300)	19.2% (5/26)	4.6	0.001	1.69 – 12.55
Cleaning bathroom #3 at Jacks Valley	325	58.6% (51/87)	46.6% (111/238)	1.6	0.06	0.99 – 2.66
Falling into water on obstacle course	324	46.5% (66/142)	52.7% (96/182)	0.8	0.26	0.50 – 1.21
Drinking/brushing teeth with water from source other than water trailer[a]	326	58.0% (123/212)	34.2% (39/114)	2.7	0.0004	1.66 – 4.27

[a]Statistically significant association

ill, they would have quickly contaminated their sleeping tents and common use bathrooms. The squadron whose members were not training at Jacks Valley on 20 July would have avoided potential exposure at the dining facility on that day. Moreover, the squadron's tent site and bathrooms were located some distance away from the other tents and bathrooms, which may have resulted in less exposure to virus. By the time the outbreak was in full swing and these cadets would have been exposed to a greater number of ill basic cadets, the isolation flight had been established.

Finally, individuals who used water for drinking or teeth brushing from a source other than the water trailer were much more likely than others to become ill (OR 2.7; p=0.0004) **(Table 1)**. With few exceptions, the only water sources other than the trailer that were used by basic cadets were bathroom faucets. Although not confirmed during the investigation, it is likely that the water from the bathroom faucets was potable, but that the faucets themselves were contaminated. Moreover, members who were willing to disregard signs directing them not to drink from the faucets may have engaged in other behaviors that increased their risk of exposure to norovirus (e.g., lack of hand washing). Further analysis of the risk associated with the use of water other than from the trailer is warranted.

During the course of this investigation, an inquiry made to local public health authorities about similar GI illness outbreaks in the community revealed no other reports of concern during the same period. However, USAFA Public Health was notified of an increase in GI illness among children and staff at the base Child Development Center. Members of the USAFSAM team visited the Child Development Center to examine the list of possible norovirus cases, construct an epidemic curve, and conduct trace back of cases to identify any links to the BCT-related outbreak. Between 21-29 July, 17 children in the infant and toddler rooms and 8 staff members were ill with vomiting and/or diarrhea. Trace back revealed no epidemiological links to known cases of norovirus. Nevertheless, control measures were promptly implemented, and the outbreak quickly resolved. On 2 August, a stool sample collected from an ill child on 29 July was reported positive for norovirus genogroup II (a different virus from that associated with the BCT outbreak). Without laboratory testing, this norovirus-related outbreak would not have been characterized as such and possibly might have worsened; in addition, it might have been wrongly associated with the outbreak among cadets.

During the first week of August, only 18 suspected cases of norovirus were detected at USAFA, despite the return of 3,000 upper class cadets to campus and extensive mixing of students as the academic year commenced. No additional suspected or confirmed cases were identified after 5 August.

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Notice to Readers:

Department of Defense laboratory capabilities for testing for norovirus infection

The U.S. Air Force School of Aerospace Medicine (USAFSAM) and the U.S. Naval Health Research Center (NHRC) offer diagnostic testing for norovirus infection as a service to DoD public health authorities and clinicians for outbreak characterization. Stool specimens collected as part of an outbreak investigation can be sent to USAFSAM or to NHRC for diagnostic molecular testing for the presence of norovirus and for the genogroup of any norovirus identified. In the context of an outbreak investigation, it is not necessary to send specimens from every patient participating in the outbreak. A representative sample (5 to 8 symptomatic patients) will usually suffice.

Points of contact for norovirus testing at the two DoD laboratories are:

USAFSAM:
Laboratory Customer Service
(937) 938-4140 DSN 798-4140
Email: usafsam.phecussv@wpafb.af.mil

NHRC:
Enteric Disease Surveillance Laboratory
Naval Health Research Center
San Diego, CA 92106
Dr. Shan Putnam, (619) 553-8552
Email: shan.putnam@med.navy.mil
Dr. Ramona McCaffrey, (619) 553-4347
Email: ramona.mccaffrey@med.navy.mil

Historical Perspective: Norovirus Gastroenteritis Outbreaks in Military Forces

Throughout history, acute gastroenteritis and diarrheal disease outbreaks have been significant causes of morbidity among deployed military forces. After laboratory identification of etiologic agents became possible, the dominant pathogens in these outbreaks have historically been bacterial (e.g., *Shigella*, *Salmonella*, *Campylobacter*, *E.coli*). However, viruses are becoming increasingly common as the causative agents in gastroenteritis outbreaks in military operational settings; the most common viruses implicated are noroviruses.[1-3]

Noroviruses were the first viruses documented as causes of gastroenteritis; in 1972, the virus was detected in stool samples collected during a 1968 Centers for Disease Control (CDC) investigation of an outbreak of gastrointestinal illness in an elementary school in Norwalk, Ohio. Norwalk virus was officially renamed norovirus in 2002.[4]

Noroviruses, a separate genus in the *Caliciviridae* family, are considered the leading cause of non-bacterial gastroenteritis worldwide. The CDC has estimated that noroviruses account for over 95 percent of viral gastroenteritis and cause approximately 23 million gastroenteritis cases per year in the United States.[5]

Noroviruses have several attributes that enable their role as a leading cause of acute gastrointestinal illness outbreaks. The viruses can be transmitted through multiple routes, including person-to-person direct contact and exposure to contaminated food, water, aerosols, and fomites. Noroviruses are very stable in the environment; of note in this regard, they can survive freezing and temperatures as high as 140°F and they are resistant to standard disinfection methods. Noroviruses are highly infectious agents; as such, they require low doses to establish infections in susceptible human hosts. The incubation period is 10-51 hours.[6] Noroviruses have a prolonged shedding period which promotes secondary transmissions. Finally, infections with norovirus do not confer lasting immunity (partially due to the diversity of viral strains).[6]

Norovirus outbreaks often occur in confined settings such as hospitals, cruise ships, nursing homes and schools, as well as military training sites, encampments, and Navy ships.

Norovirus outbreaks in military settings

Outbreaks of norovirus gastroenteritis have been reported in multiple, varied military settings. Notable examples of recent food-borne point source outbreaks have occurred on an Israeli training base,[7] a German military base,[8] and in a French military parachuting unit.[9] In this issue of the *MSMR*, Chapman and colleagues describe an outbreak among cadets at the US Air Force Academy.

TABLE 1. Reported norovirus outbreaks in military forces during Operation Enduring Freedom and Operation Iraqi Freedom

Date	Setting	Number of cases	Description	Reference
2002	British Army, field hospital, Bagram, Afghanistan	29	Cases primarily among hospital staff; 10 cases evacuated to hospitals in the U.K.;1 case treated in Germany; nosocomial cases required field hospital to be closed	16
2002	U.S. Navy, USS Theodore Roosevelt, aircraft carrier	520	Outbreak occurred after leaving Norfolk, VA; lab confirmed	22
2002	U.S. Navy, USS Constellation, aircraft carrier	747	Outbreak occurred after leaving Singapore; lab confirmed	22
2003	British troops, Iraq	1,340	First month of British invasion in Iraq; 73% of cases required hospital admission; 36% of cases were hospital personnel; fresh local produce was likely source	3
2003	U.S. Marine Corps, Iraq	30	30 lab confirmed cases; first confirmation of norovirus gastroenteritis in theater using field lab	21
2003	U.S. Navy, USS Enterprise, aircraft carrier	96	Outbreak occurrred after leaving Norfolk, VA; lab confirmed	22
2003	U.S. Navy, USS Vinson, aircraft carrier	107	Outbreak occurred after leaving Hawaii; lab confirmed	22
2003	British Navy, RFA Argus, Casualty Receiving Ship	37	Norovirus and other enteric viruses detected; salad considered source of outbreak	19
2003-2006	British troops, multiple outbreaks, Shaibah, Iraq	Unknown; 43 positive samples	Multiple norovirus strains detected in 5 of 8 outbreaks	19
2007	British troops, multiple outbreaks, Basra, Iraq	Unknown; 29 positive samples	Multiple norovirus strains detected in 1 of 2 outbreaks	19

Reports of outbreaks in deployed settings are common. Norovirus outbreaks occurred numerous times in troops during Operations Desert Shield and Desert Storm.[10-12] Several published reports have documented significant norovirus outbreaks aboard naval vessels, with attack rates ranging from 6 to 13 percent.[13, 14] Even when reported outbreaks are described as mild, they can have significant impacts on troop health and operational effectiveness.[15]

During the current conflicts in Iraq and Afghanistan, norovirus outbreaks have continued to be a significant threat to deployed personnel both ashore and afloat. A summary of published reports of such outbreaks is detailed in **Table 1**.

Of note, reported outbreaks in Iraq and Afghanistan were clustered during the beginning of combat operations in each respective theater. Two early outbreaks in British forces were especially severe. The 2002 outbreak in Afghanistan was notable because of severe outcomes requiring medical evacuation of 11 patients to hospitals in the U.K. and Germany. This outbreak demonstrated that patients who may be dehydrated or otherwise compromised because of deployment to an austere environment are at elevated risk of serious outcomes.[16,17] In the 2003 outbreak among British troops in Iraq, 975 of 1,340 affected soldiers were admitted to the supporting field hospital where significant transmissions of the virus to the hospital staff occurred.[15,18,19]

EDITORIAL COMMENT

Although the accumulated evidence to date indicates that noroviruses have been, and continue to be, significant threats to the health and operational effectiveness of military members, several factors have made it difficult to assess the true burden of norovirus in military forces. In many gastroenteritis outbreaks, even when noroviruses were the suspected etiologic agent, limited diagnostic capabilities and capacities have often prevented confirmation of clinical suspicions. While diagnostics for norovirus have improved (see Notice to Readers, p. 6), diagnostic assays have often been unavailable in deployed settings. In addition, specimen collection has often not been done or collection methods have been suboptimal.[15] However, focused efforts to improve enteric surveillance have strengthened outbreak investigation methods.[20] More robust molecular epidemiologic evidence would greatly aid vaccine development, and continued emphasis on improving surveillance methods is warranted.[15]

Information from previous outbreaks has identified several avenues for prevention of norovirus outbreaks. Sanitation and personal hygiene practices (e.g., hand washing) should be emphasized and strictly enforced, especially in certain occupational settings (e.g., healthcare workers, food handlers, armored transport personnel). Local produce has been implicated in several outbreaks among deployed military members; in deployed settings, local produce should not be consumed unless it is properly disinfected or cooked. Infected personnel may have prolonged periods of viral shedding; in turn, appropriate quarantine and isolation measures should be enforced. In medical treatment facilities that care for norovirus outbreak-associated patients, infection control precautions must be strictly observed to avoid transmissions of the virus to hospital staff.[15, 21]

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Poisoning-related Hospitalizations and Risk Factors for Self-inflicted Poisoning in the Active Component, U.S. Armed Forces, 2001-2010

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Self-inflicted poisoning is a common method of suicide but results in many more injuries than deaths. During 2001-2010 there were 14,979 poisoning-related hospitalizations among 13,971 active component military members. Medications for pain and psychiatric conditions were the causal agents of two-thirds of all poisoning hospitalizations. Rates of hospitalization for poisoning were relatively stable during the period; the highest rates were among females, teenaged service members, and Army members. Of all poisoning-related hospitalizations, approximately two-thirds (67.5%) were estimated as intentionally self-inflicted (based on reported "external cause of injury" codes and relevant comorbid mental disorder diagnoses).

Poisonings occur when substances are ingested, inhaled, injected or absorbed through the skin in quantities that are harmful to the body.[1] Examples of potential poisons to which U.S. military members may be exposed include alcohol,[2] psychotropic medications,[3] animal and insect venom,[4] carbon monoxide,[5] and hydrogen sulfide.[6] Poisoning can be intentional (e.g., suicide, homicide) or unintentional (e.g., accidental prescription drug overdose, occupational exposure).

Poisoning is the most common method of suicide among females in both U.S. civilian and military populations.[7,8] However, attempts to intentionally harm oneself with poison (hereafter "self-inflicted poisoning" or poisoning involving "self-harm") result in many more injuries than deaths. In 2007, there were an estimated 669,123 emergency department visits for drug-related poisonings in the U.S., of which 44 percent were related to accidental or intentional overdoses of antidepressants and analgesics.[9] In civilians, the highest rates of self-inflicted poisonings are among white females 15-20 years old.[9,10]

The circumstances and intents associated with poisonings and other injuries may be coded on administrative records of medical encounters using "external cause of injury" codes (E-codes). However, E-codes are not recorded for all injury and poisoning-related medical encounters. In an attempt to identify hospitalizations resulting from intentional self-harm when E-codes were incompletely recorded, Patrick and colleagues applied an algorithm that used information on the type of injury and the presence of a mental health disorder diagnosis to impute intent. The selected combinations of diagnostic codes on the same hospital record predicted self-harm with a sensitivity, specificity and positive predictive value of 74 percent, 98 percent and 73 percent, respectively, in a general U.S. population.[11]

This report summarizes the frequencies, rates, trends and correlates of risk of poisoning-related hospitalizations – particularly, those due to self-inflicted poisonings – of active component service members since 2001.

METHODS

The surveillance population consisted of all individuals who served in an active component of the U.S. military anytime from 1 January 2001 to 31 December 2010. A poisoning-related hospitalization was defined as an inpatient encounter with a diagnosis (in any diagnostic position) of poisoning either by pharmaceutical drugs ("poisoning by drugs, medicinal and biological substances": ICD-9-CM: 960-977) or nonmedicinal toxic substances including alcohol ("toxic effects of substances chiefly nonmedicinal as to source": ICD-9-CM: 980-989). Administrative records of inpatient encounters used for analyses are routinely maintained in the Defense Medical Surveillance System (DMSS) and Theater Medical Data Store (TMDS).

Intentionally self-inflicted poisoning was defined as a poisoning-related hospitalization with at least one of the following: an external cause of injury code (E-code) for "suicide and self-inflicted poisoning" (ICD-9-CM: E950-E952); a health status code (V-code) indicating "suicidal ideation" (V62.84); a death record indicating suicide within one day of the poisoning-related hospitalization; or an ICD-9-CM diagnosis of depression, personality disorder, mania, adjustment reaction, or unspecified non-psychotic mental disorder. These comorbid mental health disorder diagnoses were selected based on an algorithm developed by Patrick et al. to identify injury and poisoning hospitalizations that involved self-harm but were not coded as such.[11] Poisoning hospitalizations with E-codes indicating "accidental poisoning" (E850-E869) or effects of correct medicinal substances properly administered (E930-E949) were not classified as self-inflicted.

A multivariate logistic regression model was used to determine risk factors for self-inflicted poisoning among service members hospitalized with poisoning diagnoses.

RESULTS

Between 1 January 2001 and 31 December 2010, there were 14,979 poisoning-related hospitalizations of 13,971 active component military members. Of all poisoning-related hospitalizations, 12,984 were associated with poisoning by

TABLE 1. Poisoning-related hospitalizations, by category of causal agent, active component, U.S. Armed Forces, 2001-2010

	Total[a]			Pharmaceutical-related			Other drug/toxin-related		
	No.	Rate[b]	% total	No.	Rate[b]	% total	No.	Rate[b]	% total
Total	14,979	105.0		12,984	91.0		2,646	18.5	
Sex									
Female	4,107	198.2	27.4	3,864	186.5	29.8	400	19.3	15.1
Male	10,872	89.1	72.6	9,120	74.8	70.2	2,246	18.4	84.9
Service									
Army	8,328	164.4	55.6	7,168	141.5	55.2	1,499	29.6	56.7
Navy	2,659	75.8	17.8	2,418	68.9	18.6	368	10.5	13.9
Air Force	1,828	52.8	12.2	1,570	45.3	12.1	363	10.5	13.7
Marine Corps	1,990	108.4	13.3	1,668	90.9	12.8	395	21.5	14.9
Coast Guard	174	44.2	1.2	160	40.6	1.2	21	5.3	0.8
Age									
17-19	1,729	265.3	11.5	1,537	235.9	11.8	220	33.8	8.3
20-24	7,839	164.8	52.3	6,900	145.0	53.1	1,263	26.5	47.7
25-29	3,013	92.6	20.1	2,602	80.0	20.0	584	18.0	22.1
30-34	1,197	56.5	8.0	999	47.2	7.7	259	12.2	9.8
35-39	727	39.8	4.9	592	32.4	4.6	180	9.9	6.8
40-44	344	30.9	2.3	261	23.5	2.0	96	8.6	3.6
45-54	125	23.9	0.8	89	17.0	0.7	42	8.0	1.6
55+	5	17.8	0.0	4	14.2	0.0	2	7.1	0.1
Military status (pay grade)									
Junior enlisted	11,700	187.7	78.1	10,425	167.2	80.3	1,805	29.0	68.2
Senior enlisted	2,769	48.8	18.5	2,257	39.5	17.4	678	11.9	25.6
Junior officers	309	21.3	2.1	226	15.6	1.7	100	6.9	3.8
Senior officers	131	15.0	0.9	76	8.7	0.6	63	7.2	2.4
Race/ethnicity									
American Indian/Alaskan Native	305	128.0	2.0	279	117.1	2.1	38	15.9	1.4
White, non-Hispanic	10,067	111.5	67.2	8,653	95.9	66.6	1,862	20.6	70.4
Hispanic	1,423	98.9	9.5	1,229	85.4	9.5	258	17.9	9.8
Black, non-Hispanic	2,399	96.5	16.0	2,158	86.8	16.6	331	13.3	12.5
Other	104	96.5	0.7	90	83.0	0.7	19	17.5	0.7
Asian/Pacific Islander	507	77.7	3.4	439	67.3	3.4	92	14.1	3.5
Unknown	174	54.8	1.2	136	42.8	1.0	46	14.5	1.7

[a]Pharmaceutical-related and other drug/toxin-related hospitalizations do not sum to the total because 651 hospitalizations involved both types of agents.
[b]Rate per 100,000 person-years of military service

pharmaceutical drugs (with or without nonmedicinal substances) and 2,646 were associated with toxic effects of nonmedicinal substances (hereafter "other drugs/toxins") with or without pharmaceutical drugs. There were 651 hospitalizations that involved both pharmaceutical and other drugs/toxins **(Table 1)**. Pain medications and psychotropic drugs were the causal agents of approximately two-thirds of all poisoning-related hospitalizations **(Figure 1)**. The most frequent other drugs/toxins were alcohol (6% of all poisoning hospitalizations) and venom from bites of poisonous animals or insects (5%).

The demographic subgroups with the highest rates of poisoning-related hospitalizations were service members less than 20 years old (265.3 per 100,000 person-years [p-yrs]), females (198.2 per 100,000 p-yrs), and those serving in the Army (164.4 per 100,000 p-yrs) **(Table 1)**. Rates were higher among enlisted members than officers and declined monotonically with increasing age and rank.

Overall, annual rates of poisoning-related hospitalization were fairly stable throughout the period with no clear temporal trend (range: 83.3 to 122.7 per 100,000 p-yrs) **(data not shown)**. However, in the

Army, rates of poisoning-related hospitalization increased sharply between 2003 (114.2 per 100,000 p-yrs) and 2007 (209.0 per 100,000 p-yrs) and then declined moderately through 2010. Rates in the other services were consistently lower than in the Army and relatively stable throughout the period **(Figure 2)**.

The rate of pharmaceutical poisoning-related hospitalizations among females (186.5 per 100,000 p-yrs) was two and a half times the rate among males (74.8 per 100,000 p-yrs); in contrast, the rates of other drug/toxin-related poisoning hospitalizations were nearly the same among

FIGURE 1. Poisoning-related hospitalizations (n=14,979) by causal agent, active component, U.S. Armed Forces, 2001-2010
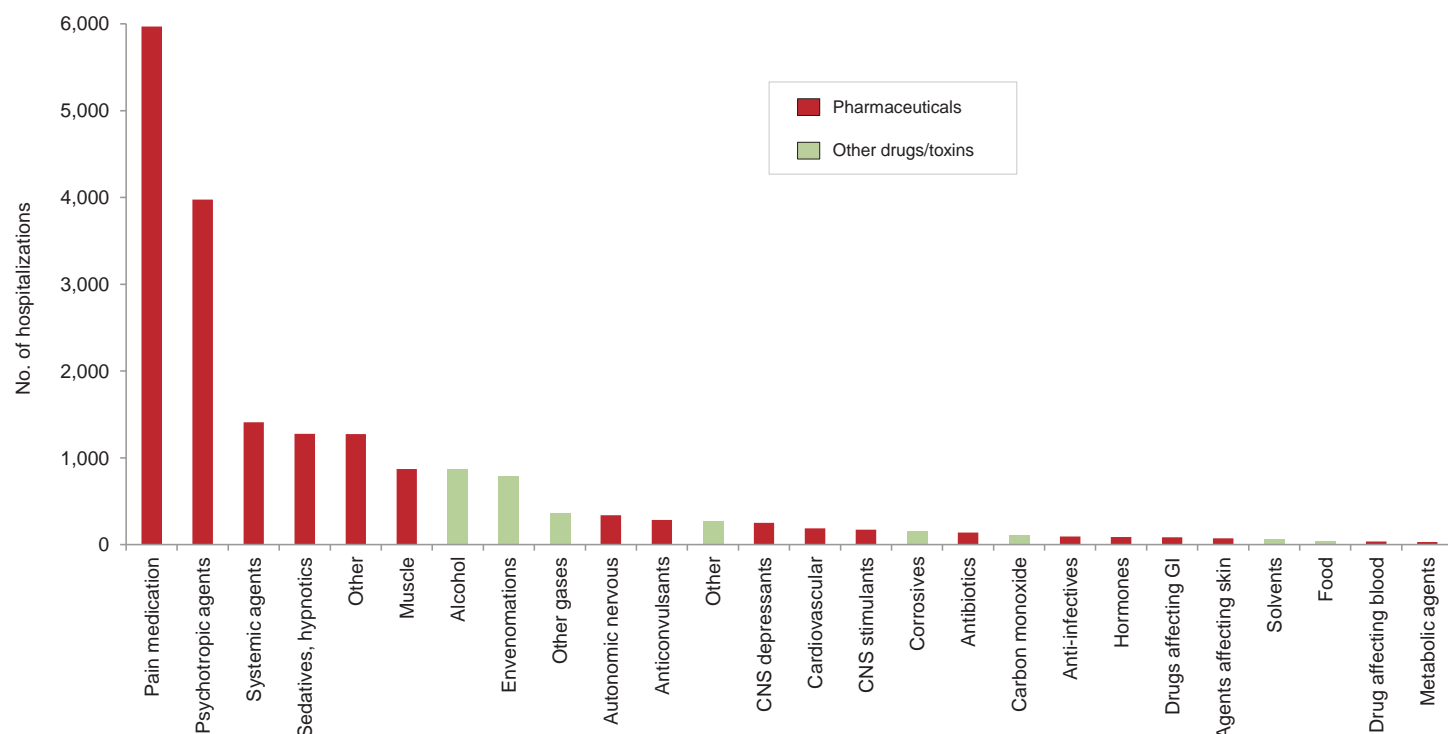
females (19.3 per 100,000 p-yrs) and males (18.4 per 100,000 p-yrs) **(Table 1, Figure 3)**. As compared to their counterparts, service members of American Indian/Alaskan Native and white race/ethnicity had higher rates of pharmaceutical poisonings, while rates of other drug/toxin poisonings were highest among white and Hispanic service members **(Table 1)**.

Self-inflicted poisoning

Of all poisoning-related hospitalizations, approximately two-thirds (n=10,111; 67.5%) were categorized as intentionally self-inflicted. Of these, slightly less than one half (n=4,722, 47%) reflected the presence of comorbid mental disorder diagnoses, and slightly more than one half (n=5,389, 53%) were reported as "self-inflicted" (E-code), "suicidal ideation"-related (V-code), or associated with a death record indicative of suicide. The moderate increase during the period in rates of hospitalizations for self-inflicted poisonings overall reflected the increase in poisoning-related hospitalizations that were documented with relevant E- or V-codes or followed by suicides; such hospitalizations

increased very sharply during 2004-2006 **(Figure 4)**. The proportions of all poisoning-related hospitalizations that were related to self-inflicted poisonings remained stable throughout the period (range 65.7%-70.4%) **(data not shown)**.

Annual numbers of hospitalizations for self-inflicted poisoning involving pharmaceuticals were higher during 2007-2010 (range, n=1,006-1,146) than during 2001-2006 (range, n=787-960). Annual numbers of hospitalizations for self-inflicted

FIGURE 2. Rates of poisoning-related hospitalizations by service, active component, U.S. Armed Forces, 2001-2010
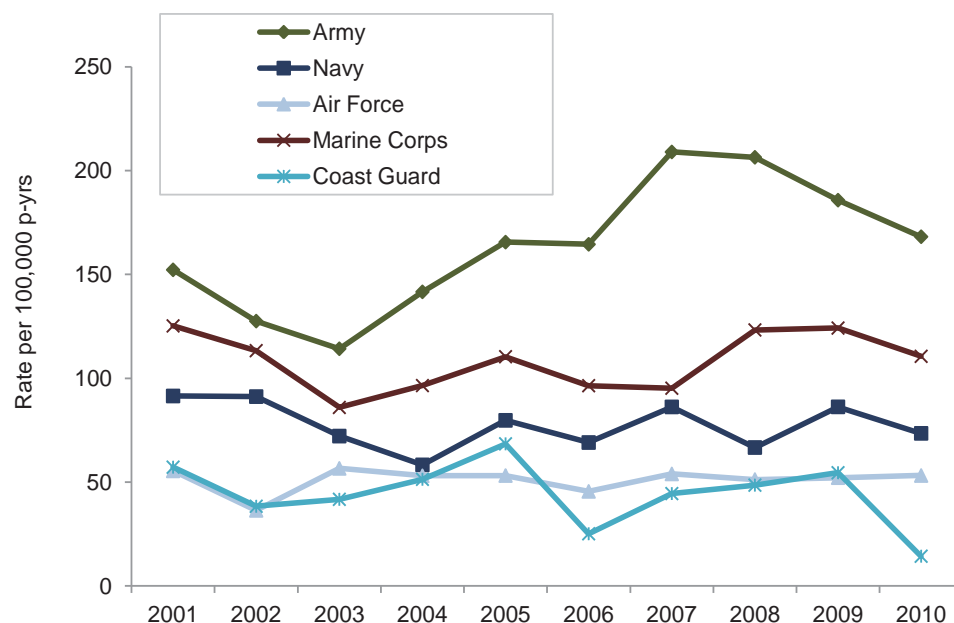
FIGURE 3. Poisoning-related hospitalizations, by gender and causal agent category, active component, U.S. Armed Forces, 2001-2010
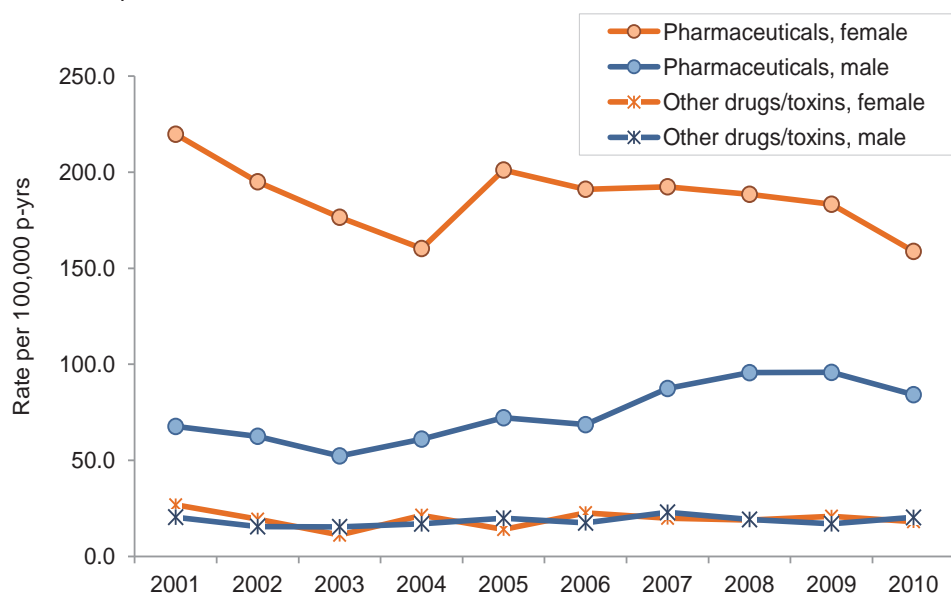
poisonings by other drugs/toxins were higher during the last five (range, n=105-138) than the first five (range, n=51-90) years of the period **(Figure 4)**.

Among service members hospitalized with poisoning diagnoses, multivariate analysis revealed statistical associations between self-inflicted poisoning and recruit status (OR= 2.04; p<0.001), female sex (OR 1.84; p<0.001), service in the Navy (OR 1.32, p<0.001) and black race/ethnicity (OR 1.18, p=0.002). Factors associated with reduced risk included age greater than 40 years (OR 0.65, p<0.001), service in the Marine Corps (OR 0.86, p=0.008) and Air Force (OR 0.88, p=0.047), and senior enlisted grade **(data not shown)**.

EDITORIAL COMMENT

Between 2001 and 2010, active component military members were hospitalized with diagnoses of poisoning nearly 15,000 times. Medications for pain and psychiatric conditions were the causal agents of two-thirds of all poisoning-related hospitalizations. Rates of poisoning hospitalizations were particularly high among females, members of the Army, and service members younger than 20 years. Risk factors for self-inflicted poisoning included recruit

status, female sex, service in the Navy, and black race/ethnicity.

More than two-thirds (67.5%) of all poisoning-related hospitalizations were associated with deliberate self-harm, as indicated by report of a self-inflicted injury (E-code) or suicidal ideation (V-code), a record of a completed suicide, or the

presence of a mental disorder diagnosis indicative of self-harm among hospitalized civilians. Application of the self-harm algorithm in this analysis nearly doubled the number of self-inflicted poisoning hospitalizations that would have been identified using causal coding alone; the finding is consistent with the experience of Patrick et al.

The results of this analysis should be interpreted in light of several limitations. For example, numbers, rates and trends of hospitalizations for self-inflicted poisonings included estimates based on comorbid mental disorder diagnoses. The apparent increase in rates of hospitalizations for self-poisoning may in part reflect increased awareness, recognition and treatment of the mental disorders used to define self-poisoning in this analysis. In addition, the increase in hospitalizations for self-poisonings overall reflects the increased use of the V-code indicative of "suicidal ideation;" this code was introduced into the ICD-9-CM in October 2005.[12] Also, the algorithm used to identify self-harm hospitalizations has not been validated in a military population. Although the algorithm had high sensitivity, specificity and positive predictive value in civilians younger than

FIGURE 4. Numbers and rates of hospitalizations for self-inflected poisoning, by category of causal agent and method used to determine self-harm, active component, U.S. Armed Forces, 2001-2010
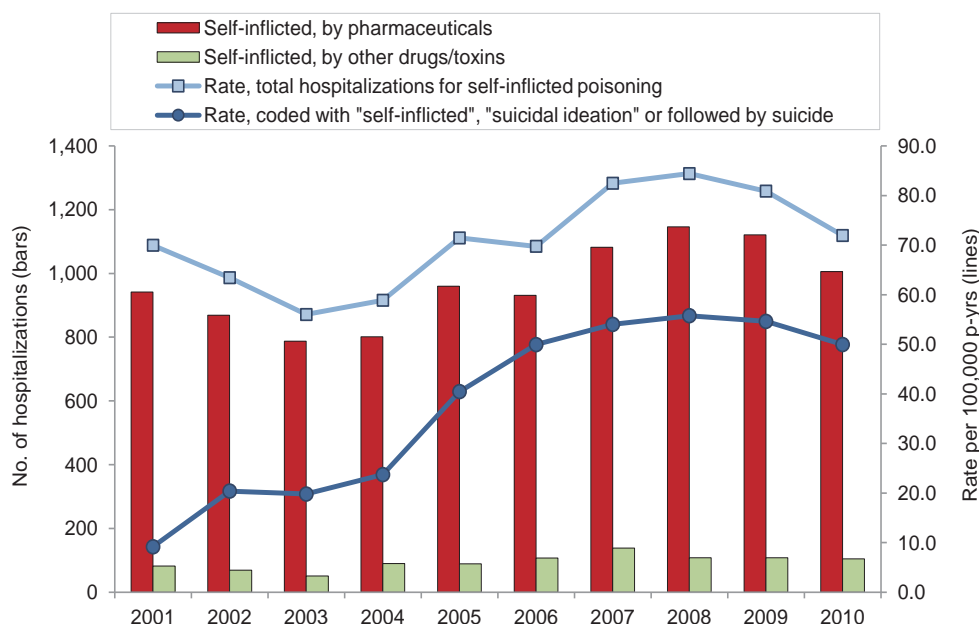
25 (the age of the majority of service members hospitalized for poisonings), U.S. military members differ from civilians overall in that they are predominately male, fully employed, and in general, have no disabling or chronically debilitating medical conditions. Finally, the records of nearly 5,000 poisoning-related hospitalizations had neither casual codes nor comorbid mental disorder diagnoses; the proportion of these that involved self-harm is unknown.

The discrepancy between the number of poisoning hospitalizations specifically coded as self-inflicted and the number estimated as likely due to self-harm suggests that some poisonings are not identified as self-inflicted during hospitalization. When health care providers evaluate the circumstances that led to hospitalizations for poisoning, the prospect that the event was due to intentional self-harm or substance abuse should guide follow-on treatment plans; such plans may involve mental health services or substance abuse treatment.

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Brief Report: Morbidity Burdens Attributable to Illnesses and Injuries in Deployed (per Theater Medical Data Store [TMDS]) Compared to Nondeployed (per Defense Medical Surveillance System [DMSS]) Settings, Active Component, U.S. Armed Forces, 2010

The Defense Medical Surveillance System (DMSS) is a centralized, administrative database that includes records of health care encounters in permanent U.S. military and civilian purchased-care facilities worldwide. Every April, the *MSMR* estimates illness and injury-related morbidity and health care "burdens" on the U.S. Armed Forces and the U.S. Military Health System (MHS) using electronic records of medical encounters from the DMSS.

Medical encounters of service members deployed to southwest Asia/Middle East (e.g., Iraq and Afghanistan) are documented in records that are maintained in the Theater Medical Data Store (TMDS).

This brief report compares the distributions of illnesses and injuries that accounted for medical encounters ("morbidity burdens") of active component members in nondeployed (per records in the DMSS) and deployed (per records in the TMDS) settings during calendar year 2010.

METHODS

The surveillance period was 1 January to 31 December 2010. The surveillance population included all individuals who served in the active component of the U.S. Army, Navy, Air Force, Marine Corps, or Coast Guard at any time during the surveillance period. For this analysis, all inpatient and outpatient medical encounters of all active component members during 2010 were summarized according to the primary (first-listed) diagnosis (if reported with an ICD-9-CM code between 001 and 999).

For summary purposes, all illness and injury-specific diagnoses (as defined by the ICD-9-CM at the 3-digit level) were grouped into 129 burden of disease-related conditions and 23 categories based on a modified version of the classification

FIGURE 1. Proportions of total medical encounters in deployed (TMDS) and nondeployed (DMSS) settings, by selected categories of illnesses and injuries (per modified Global Burden of Disease Study classification system), active component, U.S. Armed Forces, 2010
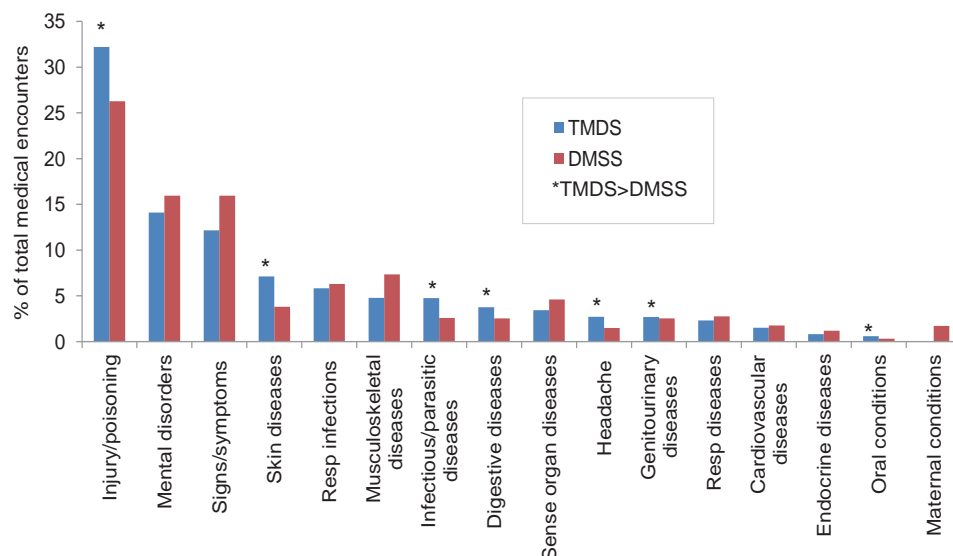
system developed for the Global Burden of Disease (GBD) Study.[1] In general, the GBD system groups diagnoses with common pathophysiologic or etiologic bases and/or significant international health policymaking importance. For our purposes, we disaggregated some diagnoses that are grouped into single categories in the GBD system (e.g., mental disorders) to increase the military relevance of the results. We also categorized injuries by the affected anatomic sites rather than the causes because external causes of injuries are not completely reported in military outpatient records.

The "morbidity burdens" attributable to various "conditions" were estimated on the basis of the total number of medical encounters attributable to each condition (with a limit of one encounter per individual per condition per day).

RESULTS

During 2010, the percentages of total medical encounters by burden of disease categories in both deployed (TMDS) and nondeployed (DMSS) settings were generally similar; in both settings, more encounters were attributable to injuries and poisonings, mental disorders, and signs and symptoms than any other categories **(Figure 1)**.

Among deployed (TMDS) compared to nondeployed (DMSS) service members, injuries and poisonings, skin diseases, infectious and parasitic diseases, digestive diseases, headache, genitourinary diseases, and oral conditions accounted for larger proportions of all illness and injury-related medical encounters **(Figure 1)**. Each of the remaining 16 illness and injury categories – including mental disorders and signs/symptoms – accounted for relatively more medical encounters among nondeployed (DMSS) than deployed (TMDS) service members.

Within these major "burden of disease" categories, seven specific conditions were among the 10 leading causes of medical encounters in deployed (TMDS) and nondeployed (DMSS) settings. Of note in

TABLE 1. Number and rank of medical encounters by selected burden of disease-related conditions, active component, U.S. Armed Forces, 2010

	Deployed medical encounters (TMDS)			Nondeployed medical encounters (DMSS)	
Rank	Condition	Medical encounters	Rank	Condition	Medical encounters
(1)	All other signs and symptoms	34,557	(1)	All other signs and symptoms	1,342,850
(2)	Back and abdomen injuries	25,519	(2)	Back and abdomen injuries	628,107
(3)	All other skin diseases	19,469	(3)	Upper respiratory infections	544,930
(4)	Upper respiratory infections	18,658	(4)	All other musculoskeletal diseases	501,766
(5)	Foot and ankle injuries	18,066	(5)	Knee injuries	444,032
(6)	Arm and shoulder injuries	17,776	(6)	Arm and shoulder injuries	433,539
(7)	Knee injuries	15,167	(7)	Substance abuse disorders	399,864
(8)	Adjustment disorders	13,669	(8)	Anxiety disorders	381,837
(9)	All other musculoskeletal diseases	12,412	(9)	Foot and ankle injuries	370,820
(10)	Unspecified injury	12,396	(10)	Mood disorders	330,325

this regard, "all other signs and symptoms" and "back and abdomen injuries" ranked first and second, respectively, in both settings. "All other skin diseases" ranked third among deployed (TMDS) but 12th among nondeployed (DMSS) service members **(Table 1)**. In deployed settings (TMDS), two diagnoses accounted for one third of all medical encounters in the "all other skin diseases" category: "other specified diseases of hair and hair follicles" and "cellulitis and abscess of unspecified sites" **(data not shown)**.

In general, mental health disorders had similar relative "burdens" in the deployed (TMDS) and nondeployed (DMSS) settings; however, the proportions of mental disorders that were attributable to various specific conditions markedly differed between the settings. For example, in the deployed setting (TMDS), "adjustment disorders" was the only mental disorder among the 10 leading specific causes of medical encounters overall; on the other hand, in the nondeployed setting (DMSS), "substance abuse disorders," "anxiety disorders," and "mood disorders" were among the 10 leading specific causes of medical encounters of service members **(Table 1)**.

EDITORIAL COMMENT

Despite the differences between deployed (i.e., TMDS) and non-deployed (i.e., DMSS) settings, the categories of illnesses and injuries that accounted for the largest morbidity and health care "burdens" among military members were similar; in both settings, injuries (particularly of the back), mental disorders, and signs and symptoms accounted for relatively large proportions of the total morbidity and health care burdens among U.S. military members. Differences that were apparent between deployed and nondeployed settings could plausibly be attributed to living in field settings during wartime. The lack of certain amenities and greater exposure to austere environmental conditions may have compromised hygienic practices and contributed to the relatively greater proportions of skin diseases, infectious/parasitic diseases, digestive diseases, and genitourinary diseases.

Encounters for certain conditions are not expected to occur often in deployment settings. For example, "substance abuse disorders" account for relatively large numbers of medical encounters among nondeployed service members but relatively few encounters during deployment (TMDS); undoubtedly, the finding reflects the prohibition of alcohol use during deployment **(data not shown)**. Moreover, the presence of some conditions, e.g., diabetes, pregnancy, congenital anomalies, may affect service members' eligibility for deployment. As a result of this selection process, deployed service members could be considered generally "healthier" than their non-deployed counterparts and, specifically, less likely to require medical care for conditions that preclude deployment. The overall result of such predeployment medical screening is diminished health care burdens (as documented in TMDS) related to certain disease categories.

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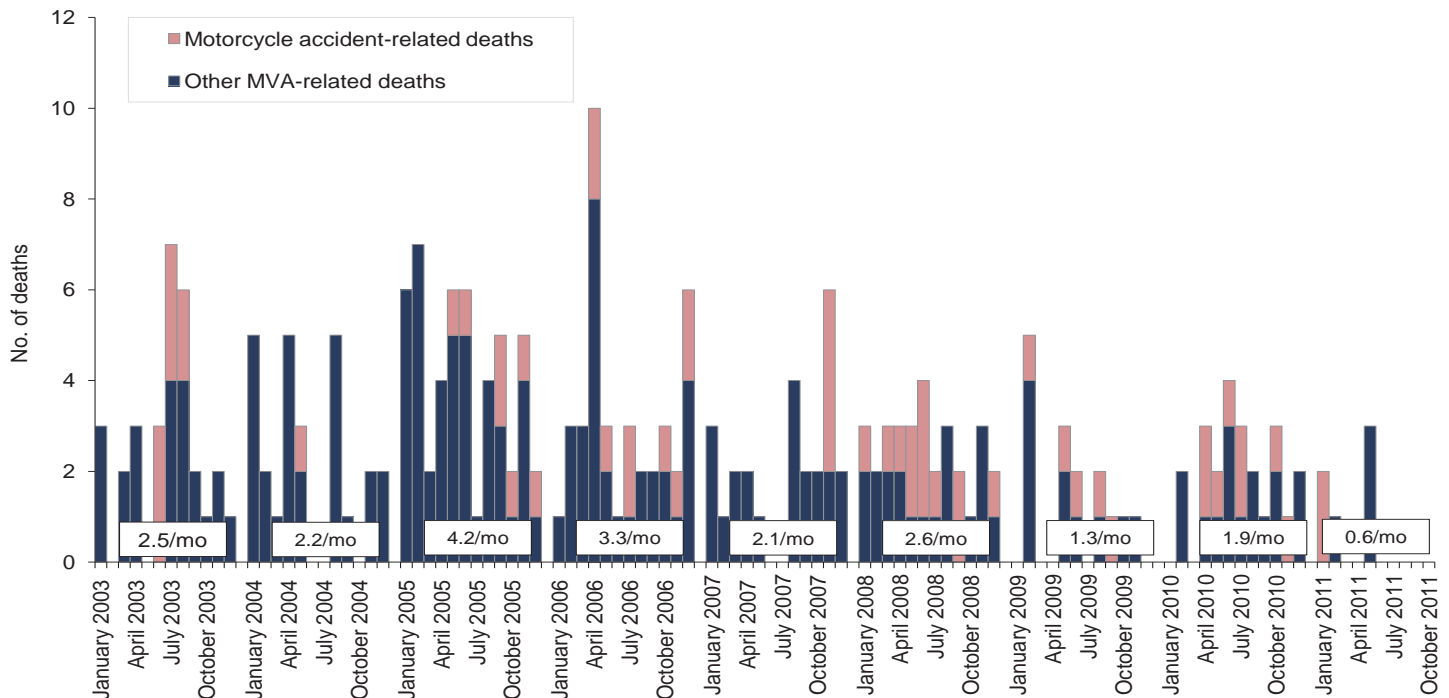
Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - October 2011 (data as of 28 November 2011)

Hospitalizations for motor vehicle accidents occurring in non-military vehicles and outside of the operational theater (ICD-9-CM: E810-E825; NATO Standard Agreement 2050 (STANAG): 100-106, 107-109, 120-126, 127-129)
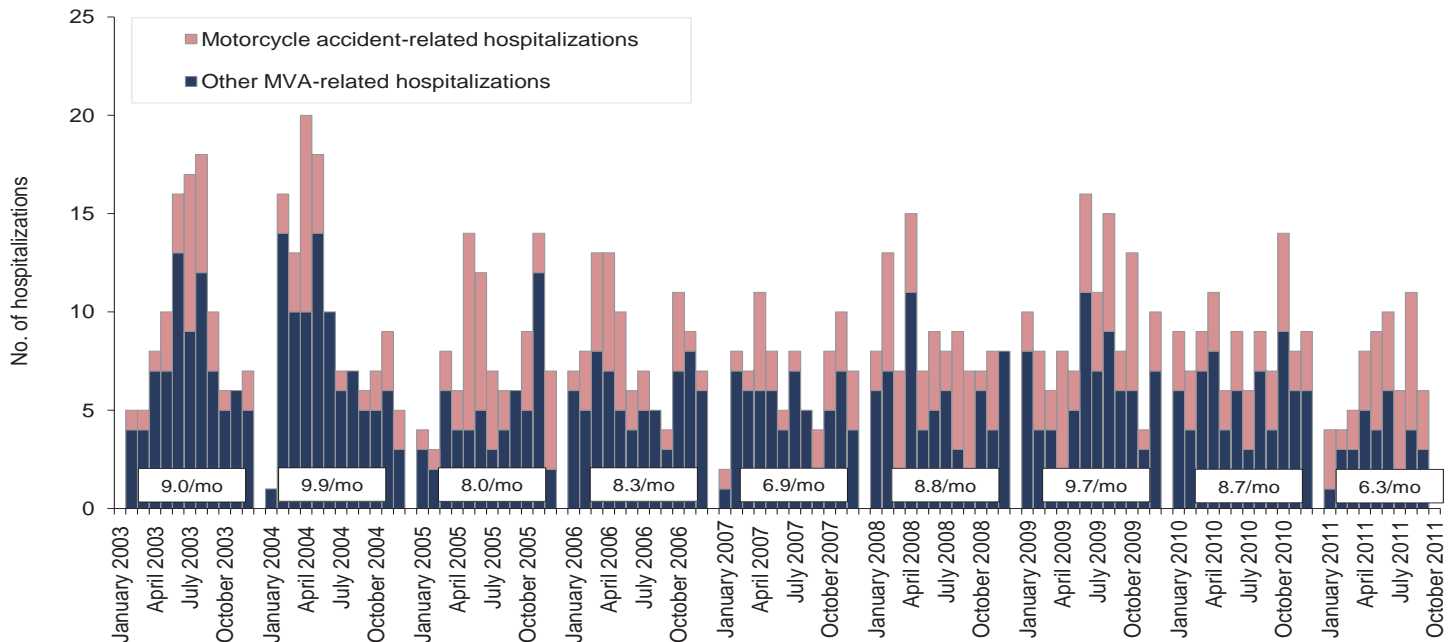
Note: Hospitalization (one per individual) while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days of another motor vehicle accident-related hospitalization.

Deaths following motor vehicle accidents occurring in non-military vehicles and outside of the operational theater (per the DoD Medical Mortality Registry)

Reference: Armed Forces Health Surveillance Center. Motor vehicle-related deaths, U.S. Armed Forces, 2010. *Medical Surveillance Monthly Report (MSMR).* Mar 11;17(3):2-6.
Note: Death while deployed to/within 90 days of returning from OEF/OIF/OND. Excludes accidents involving military-owned/special use motor vehicles. Excludes individuals medically evacuated from CENTCOM and/or hospitalized in Landstuhl, Germany within 10 days prior to death.

Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 -October 2011 (data as of 23 November 2011)

Traumatic brain injury (ICD-9: 310.2, 800-801, 803-804, 850-854, 907.0, 950.1-950.3, 959.01, V15.5_1-9, V15.5_A-F, V15.52_0-9, V15.52_A-F, V15.59_1-9, V15.59_A-F)[a]
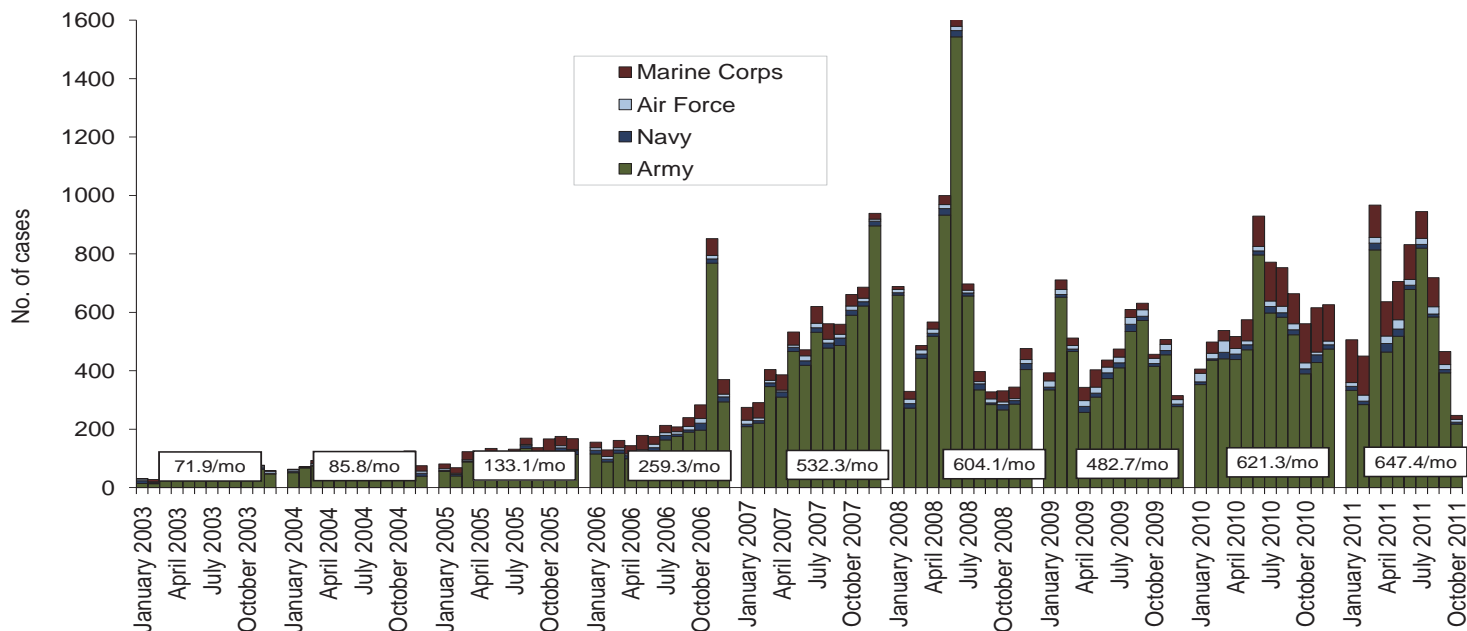
Reference: Armed Forces Health Surveillance Center. Deriving case counts from medical encounter data: considerations when interpreting health surveillance reports. *MSMR*. Dec 2009; 16(12):2-8.
[a]Indicator diagnosis (one per individual) during a hospitalization or ambulatory visit while deployed to/within 30 days of returning from OEF/OIF/OND. (Includes in-theater medical encounters from the Theater Medical Data Store [TMDS] and excludes 3,418 deployers who had at least one TBI-related medical encounter any time prior to OEF/OIF/OND).

Deep vein thrombophlebitis/pulmonary embolus (ICD-9: 415.1, 451.1, 451.81, 451.83, 451.89, 453.2, 453.40 - 453.42 and 453.8)[b]
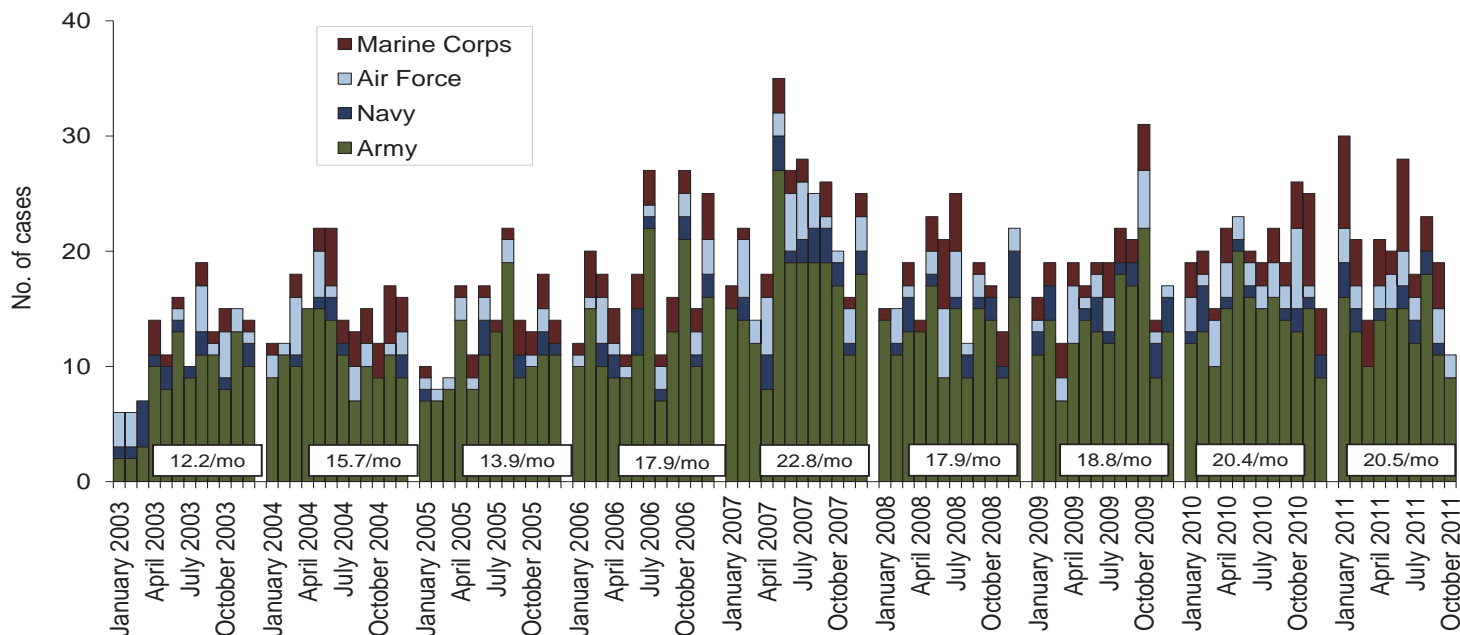
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[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 90 days of returning from OEF/OIF/OND.

Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - October 2011 (data as of 23 November 2011)

Amputations (ICD-9-CM: 887, 896, 897, V49.6 except V49.61-V49.62, V49.7 except V49.71-V49.72, PR 84.0-PR 84.1, except PR 84.01-PR 84.02 and PR 84.11)[a]
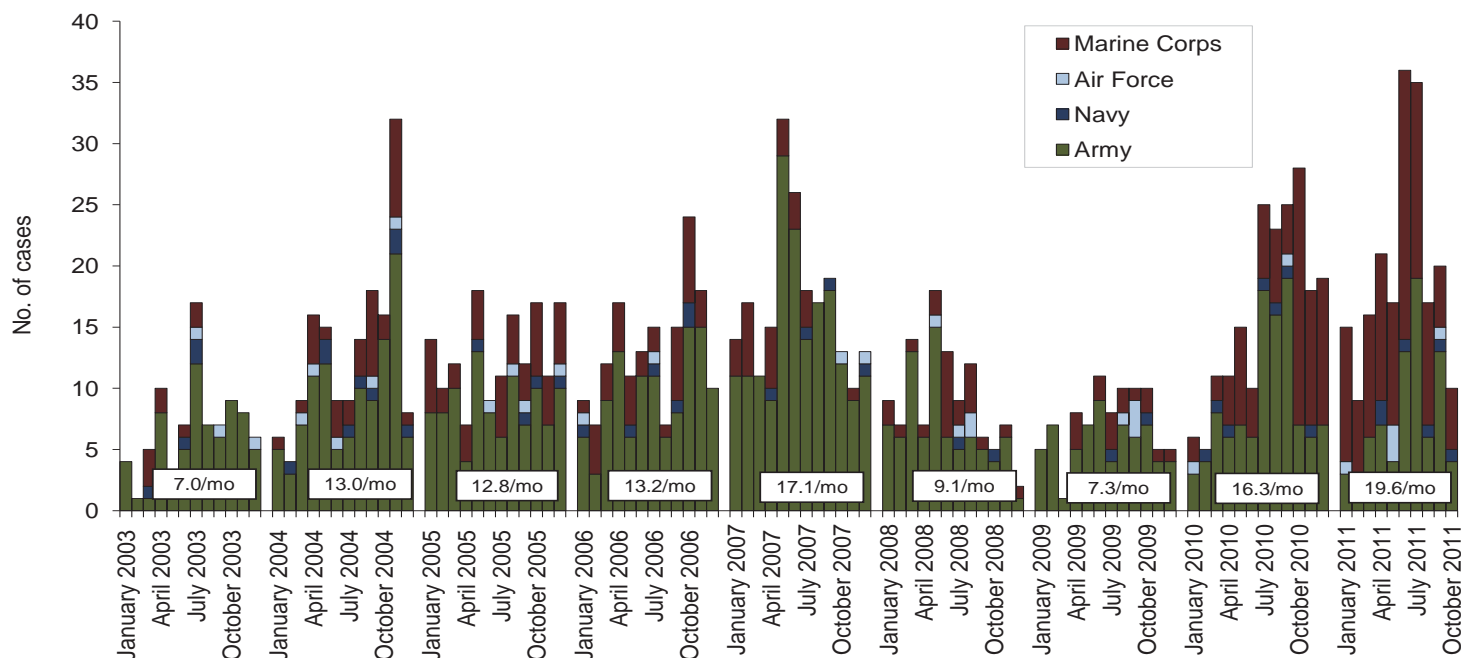
Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: amputations. Amputations of lower and upper extremities, U.S. Armed Forces, 1990-2004. *MSMR*. Jan 2005;11(1):2-6.
[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 365 days of returning from OEF/OIF/OND.

Heterotopic ossification (ICD-9: 728.12, 728.13, 728.19)[b]
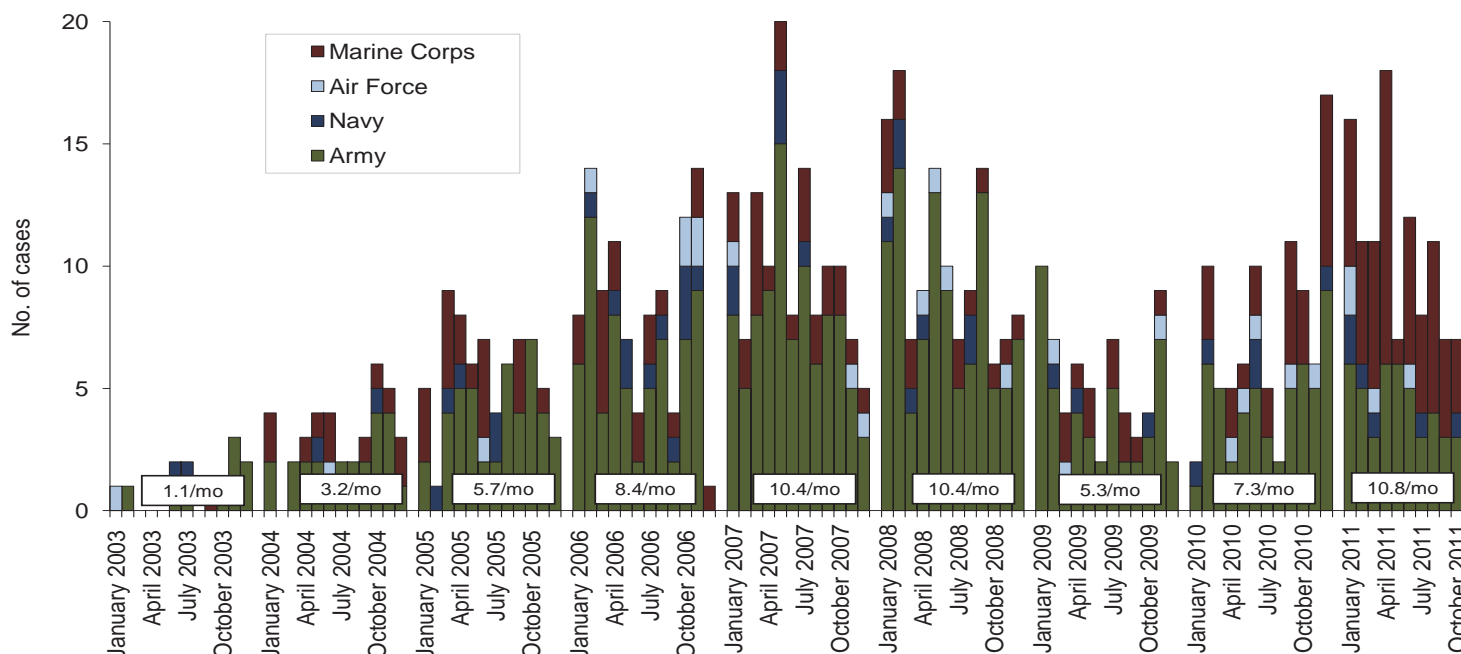
Reference: Army Medical Surveillance Activity. Heterotopic ossification, active components, U.S. Armed Forces, 2002-2007. *MSMR*. Aug 2007; 14(5):7-9.
[b]One diagnosis during a hospitalization or two or more ambulatory visits at least 7 days apart (one case per individual) while deployed to/within 365 days of returning from OEF/OIF/OND.

Deployment-related conditions of special surveillance interest, U.S. Armed Forces, by month and service, January 2003 - October 2011 (data as of 23 November 2011)

Severe acute pneumonia (ICD-9: 518.81, 518.82, 480-487, 786.09)[a]
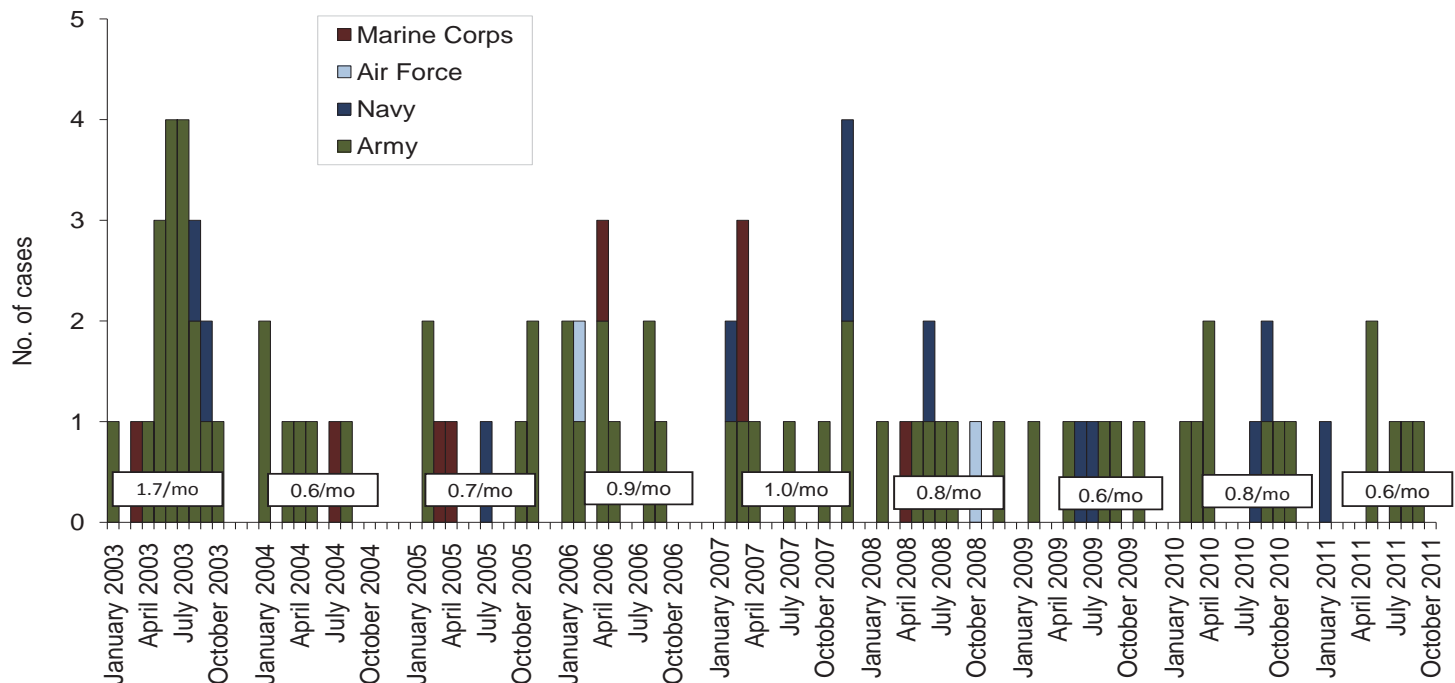
Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: severe acute pneumonia. Hospitalizations for acute respiratory failure (ARF)/acute respiratory distress syndrome (ARDS) among participants in Operation Enduring Freedom/Operation Iraqi Freedom, active components, U.S. Armed Forces, January 2003-November 2004. *MSMR.* Nov/Dec 2004;10(6):6-7.
[a]Indicator diagnosis (one per individual) during a hospitalization while deployed to/within 30 days of returning from OEF/OIF/OND.

Leishmaniasis (ICD-9: 085.0 to 085.9)[b]
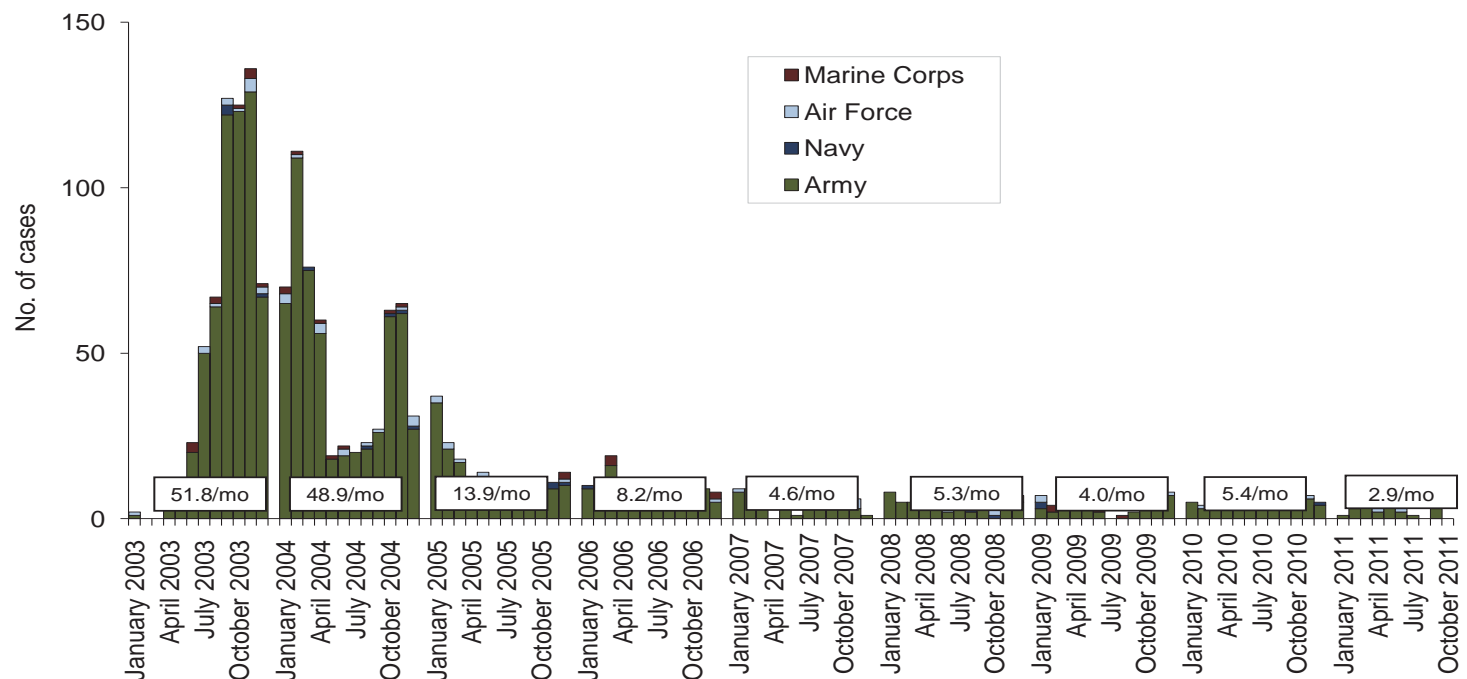
Reference: Army Medical Surveillance Activity. Deployment-related condition of special surveillance interest: leishmaniasis. Leishmaniasis among U.S. Armed Forces, January 2003-November 2004. *MSMR.* Nov/Dec 2004;10(6):2-4.
[b]Indicator diagnosis (one per individual) during a hospitalization, ambulatory visit, and/or from a notifiable medical event during/after service in OEF/OIF/OND.

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